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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/696,244

10/28/2003

Ivo Raaijmakers

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7038

20995

7590

03/01/2005

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EXAMINER

LEE, HSIEN MING

ART UNIT

PAPER NUMBER

2823

DATE MAILED: 03/01/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

10/696,244

Applicant(s)

RAAIJMAKERS ET AL.

Examiner

Hsien-ming Lee

Art Unit

2823

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☐ Responsive to communication(s) filed on \_\_\_\_.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-18 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 11, 13 and 15-18 is/are allowed.
- 6) ☒ Claim(s) 1, 2, 4, 5, 7 and 8 is/are rejected.
- 7) ☒ Claim(s) 3, 6, 9, 10, 12 and 14 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 28 December 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

HSIEN-MING LEE  
PRIMARY EXAMINER

2/23/05

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date 051804.
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_.

## DETAILED ACTION

### *Claim Objections*

1. Claim 12 is objected to because of the following informalities: the term "said materials" lacks antecedent basis. Appropriate correction is required.

### *Claim Rejections - 35 USC § 102*

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

3. Claims 1, 2, 4, 5, 7 and 8 are rejected under 35 U.S.C. 102(e) as being anticipated by Raaijmakers et al. (US 6,727,169).

In re claim 1, Raaijmakers et al. teach a method for manufacturing a semiconductor device, the method comprising, in sequence, the steps of:

- providing a semiconductor substrate 52, the substrate 52 comprising a first film being a diffusion barrier film 150 (Fig.11 and col. 17, lines 57-59), the first film 150 being exposed at least at part of the surface area of said substrate;
- exposing the substrate to an oxygen-containing reactant (i.e. hydroxyl, col. 8, lines 38-44, step 102 in Fig.3) to create a surface termination of about one monolayer of oxygen-containing groups on the exposed parts of the first film 150; and
- depositing a second film 160 onto the substrate (Fig.12).

In re claim 2, Raaijmakers et al. teach that the oxygen-containing reactant is a hydroxyl-

containing reactant (i.e. OH, col. 8, lines 42-45) and wherein the exposure with the hydroxyl-containing reactant is performed under ALD conditions (col. 8, lines 41-42) to create a surface termination of about one monolayer (col. 9, line 49) of hydroxyl groups on the exposed parts of the first film.

In re claim 4, Raaijmakers et al., in Fig. 11 and related text, teach a method for manufacturing a semiconductor device, the method comprising, in sequence, the steps of:

- providing a semiconductor substrate 52;
- depositing a diffusion barrier 150 (col. 17, lines 57-59) onto the substrate 52 by ALD;
- exposing the substrate to an oxygen-containing reactant (i.e. hydroxyl, col. 8, lines 38-44, step 102 in Fig.3) to create a surface termination of about one monolayer of oxygen-containing groups on diffusion barrier 150; and
- depositing a metal film 160 onto the substrate (Fig.12).

In re claim 5, Raaijmakers et al. teach that the oxygen-containing reactant is a hydroxyl-containing reactant (i.e. OH, col. 8, lines 42-45) and wherein the exposure with the hydroxyl-containing reactant is performed under ALD conditions (col. 8, lines 41-42) to create a surface termination of about one monolayer (col. 9, line 49) of hydroxyl groups on diffusion barrier 150.

In re claim 7, Raaijmakers et al. teach that the metal film is copper (col. 18, lines 56-57).

In re claim 8, Raaijmakers et al. teach that the liner film 150 comprises initial adhesion layer (i.e. W or Ti) and a diffusion barrier (i.e. TiN) (col. 17, lines 57-60).

***Allowable Subject Matter***

4. Claims 11, 13 and 15-18 are allowed.

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5. Claims 3, 6, 9, 10 and 14 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

6. The following is a statement of reasons for the indication of allowable subject matter:

The prior art of record neither teaches nor suggests *a monolayer of oxygen atoms at the interface* between the diffusion barrier and the metal film, the *oxygen atoms form bridges* between the diffusion barrier and the metal film; a metal oxide bridge material sandwiched between the diffusion barrier and the metal conductor, the bridge material having a *thickness of no more than about five monolayers*.

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-ming Lee whose telephone number is 571-272-1863. The examiner can normally be reached on Tuesday-Thursday (8:00 ~ 6:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 571-272-1855. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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Hsien-ming Lee  
Primary Examiner  
Art Unit 2823

Feb. 23, 005

HSIEN-MING LEE  
PRIMARY EXAMINER

2/23/005